AN APPLICATION OF MONTE CARLO SIMULATION IN

PORTFOLIO OPTIMIZATION

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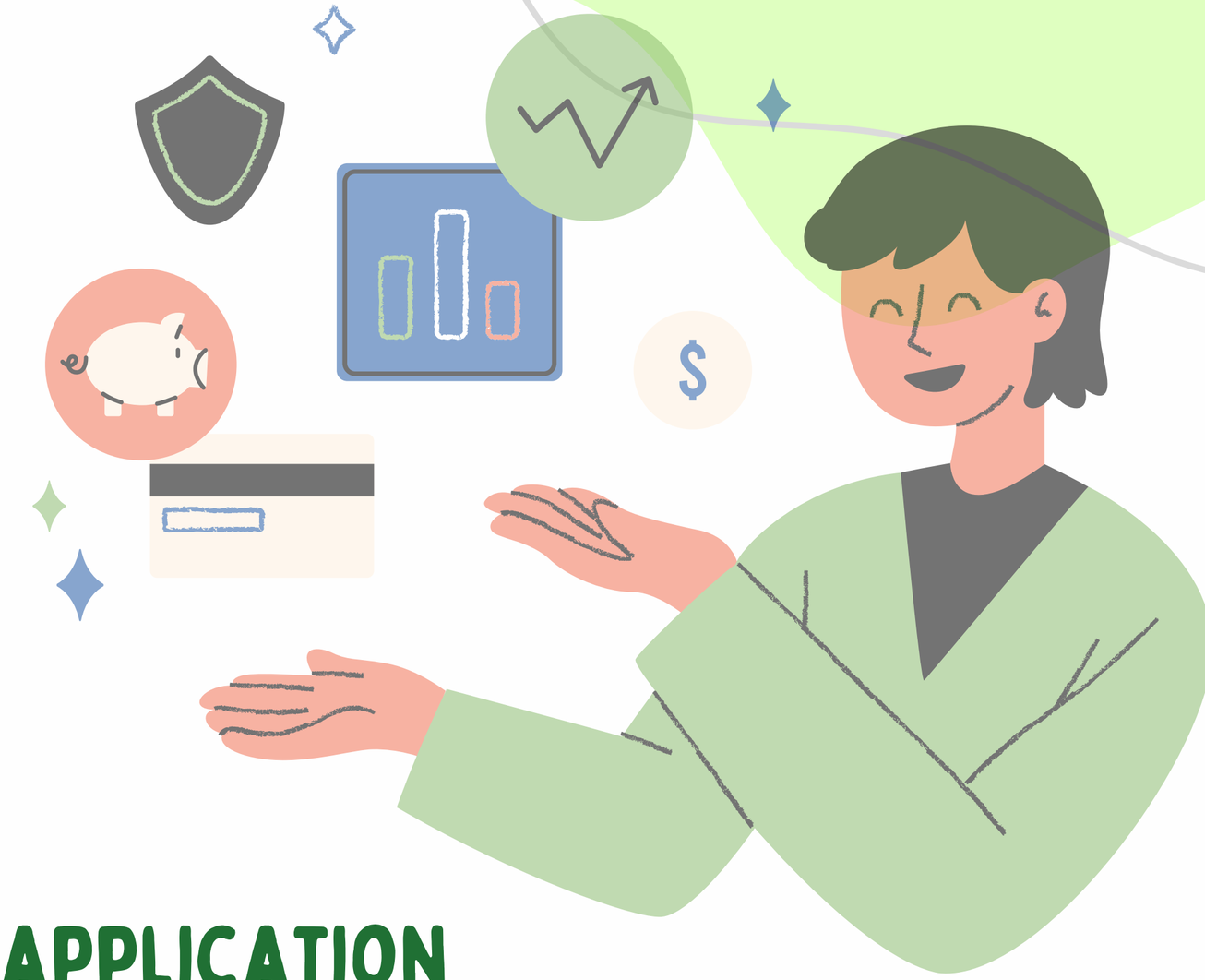
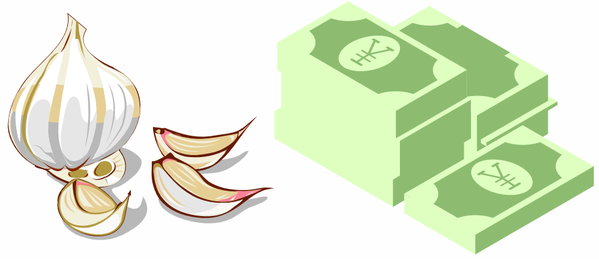


INTRODUCTON

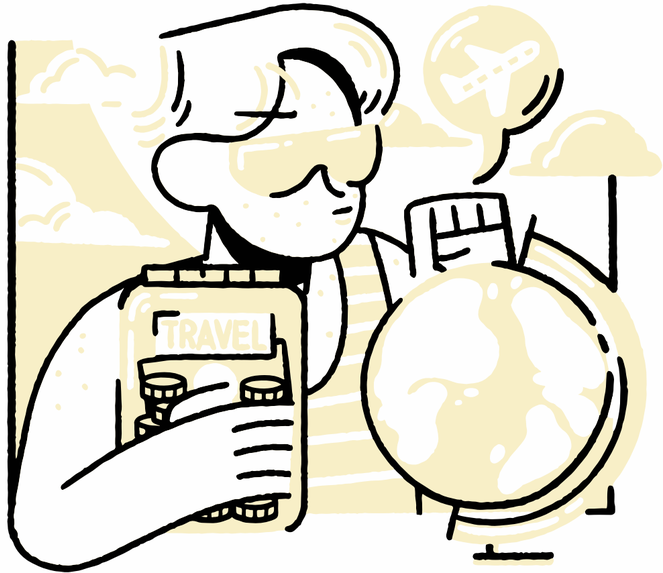
Imagine you are a chef creating a recipe for financial success while having a crystal ball to predict the future. We balance investments like flavors, and Monte Carlo simulation lets us ride the ups and downs of the market. Get ready for an adventure in creating a winning portfolio and peeking into the future of your investments!



PORTFOLIO OPTIMIZATION + MORTE CARLO

In the quest for financial success, portfolio optimization allows us to carefully select and balance investments, while Monte Carlo simulation empowers us to explore a multitude of potential market scenarios.

So, let's dive into the world of portfolio optimization and Monte Carlo simulation, where data-driven strategies lead the way to investment excellence.



PROBLEM STATEMENT

This project discusses implementation of Monte Carlo Simulations for portfolio optimization and asset allocation.

Here, this technique aims construct many random portfolios of equities in order to find three specific popular portfolio types: **minimum risk, maximum return, and maximum Sharpe Ratio.**

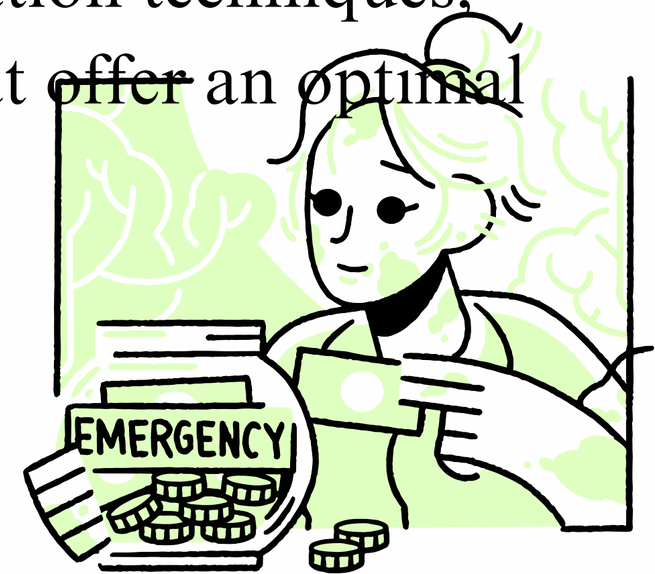
LITERATURE REVIEW

- It is a powerful computational technique for portfolio analysis.
- By running thousands of simulations, they were able to generate a distribution of portfolio returns and evaluate risk measures such as Value at Risk (VaR).
- They were able to identify optimal portfolios with higher expected returns and lower risks.

LITERATURE REVIEW

Compared with Markowitz's idea, which relies on assumptions of normally distributed returns and stationery market conditions, Monte Carlo simulation allows for the incorporation of more realistic and complex distributions of asset returns, capturing non-normalities and dynamic market behavior.

Monte Carlo simulation can be combined with other optimization techniques, such as maximizing the Sharpe ratio, to identify portfolios that offer an optimal balance between risk and return.



METHODOLOGY : MONTE CARLO SIMULATION

Monte Carlo simulation is a computational technique that utilizes random sampling and statistical analysis to model and evaluate complex systems or processes.

By generating numerous iterations of possible outcomes, it provides insights into the range of potential results and helps make informed decisions under uncertainty.

STEPS IN MONTE CARLO SIMULATION

Step 1: Determine assets

Step 2

Choose significant number of randomly generated portfolios to create (thousands) as well as a good number of simulations.

Step 3 Create randomly generated weights for each asset in the portfolio and calculate portfolio metrics of returns, risk, and Sharpe Ratio.

Step 4

Store the maximum return, minimum risk, and maximum Sharpe Ratio portfolios.

Step 5

Examime the result

DATA DESCRIPTION

• 16 Vietnamese random types of stock prices were chosen from Yahoo finance from 1-6-2019 to 1-1-2022

"VIC","VHM","GAS","VCB","HPG","TCB","FPT", "HVN", "VJC", "BHN", "MSB", "VPB", "HSG", "PNJ","NVL", "ABC"]

• With this, 5,000 random portfolios are generated in each of the 2,500 simulations that are made.

After each simulation, we take three portfolio types to exhibit some common investor goals, which provides a good example for the implementation of this method.

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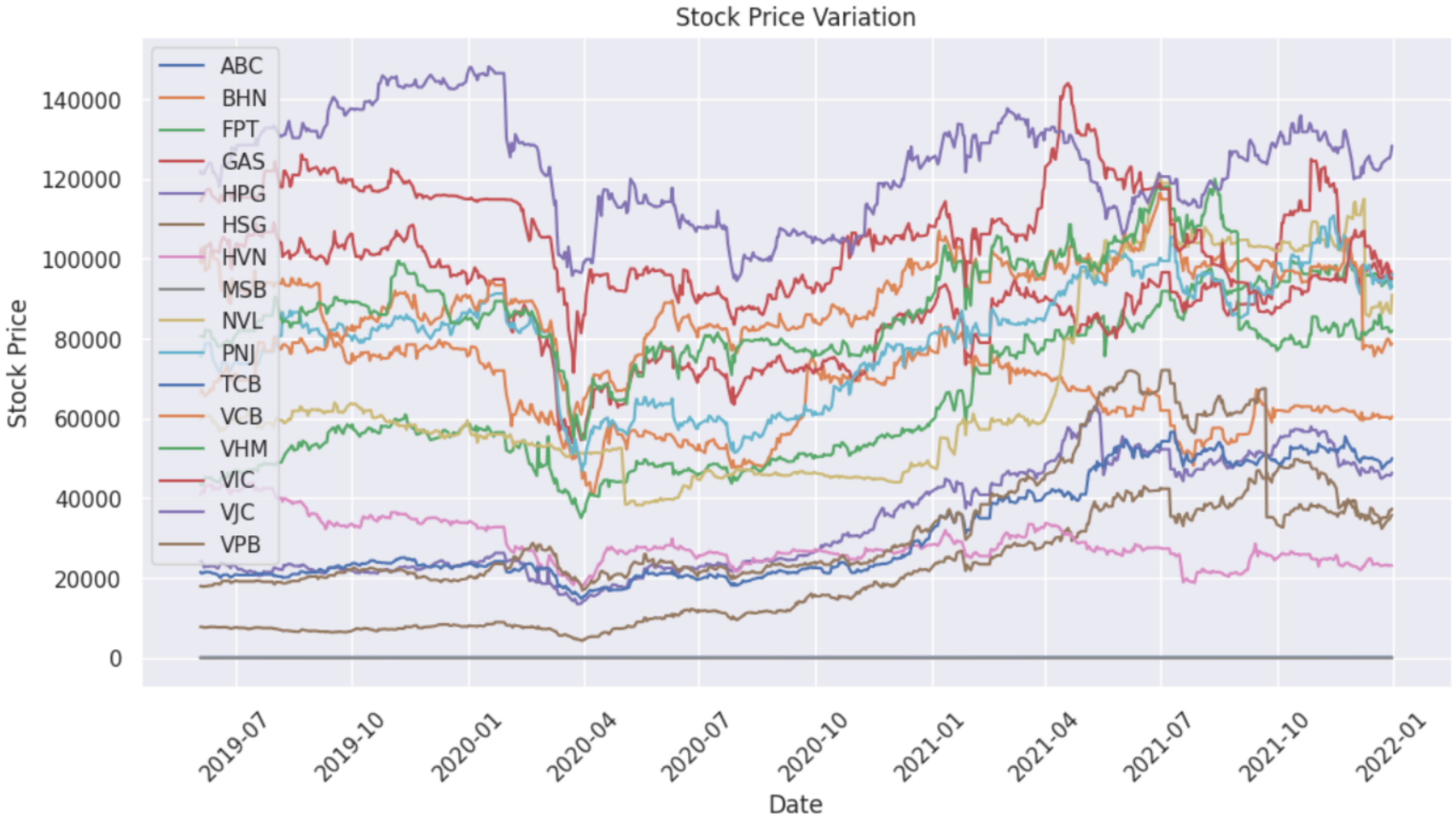

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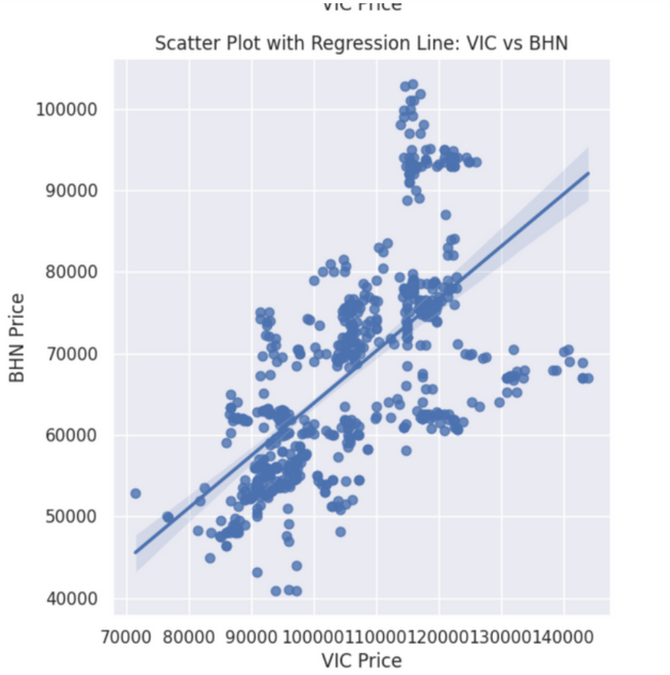
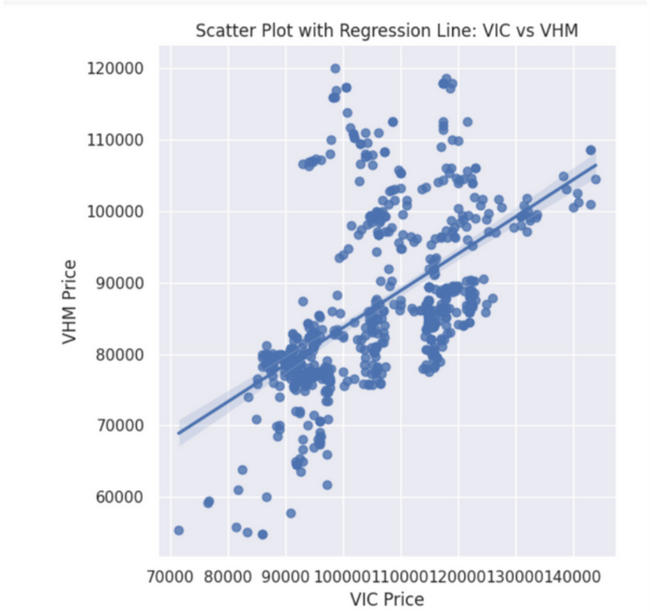
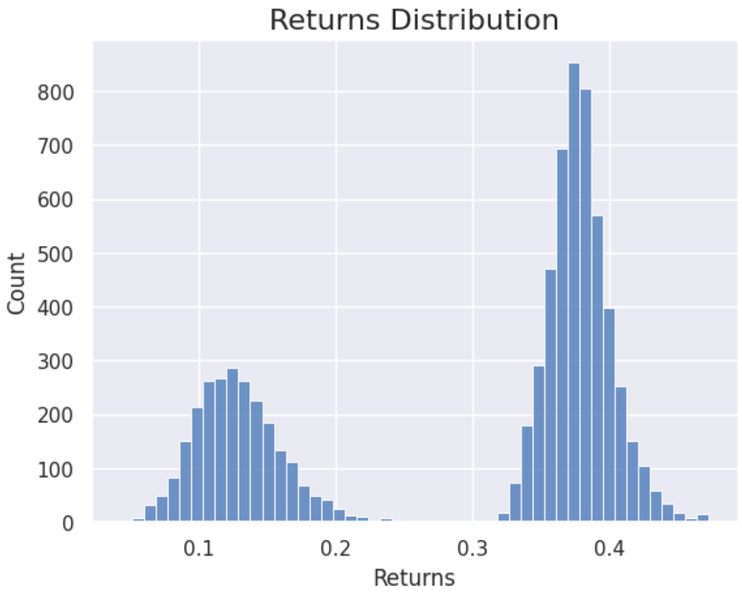


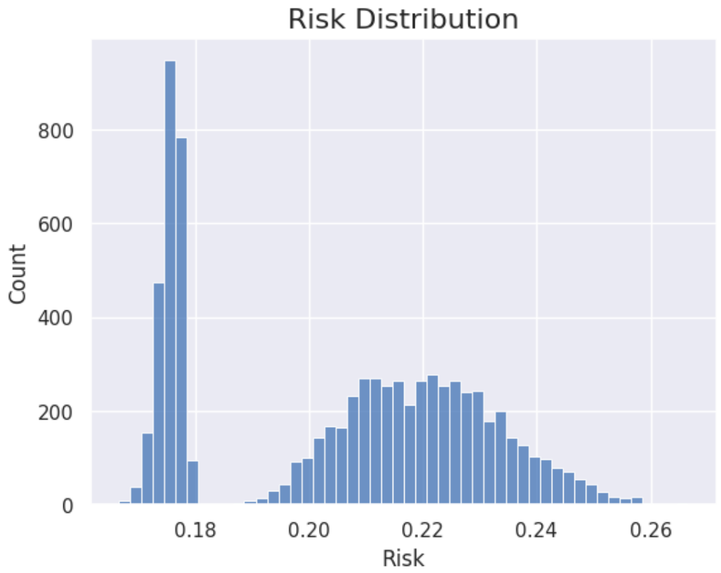


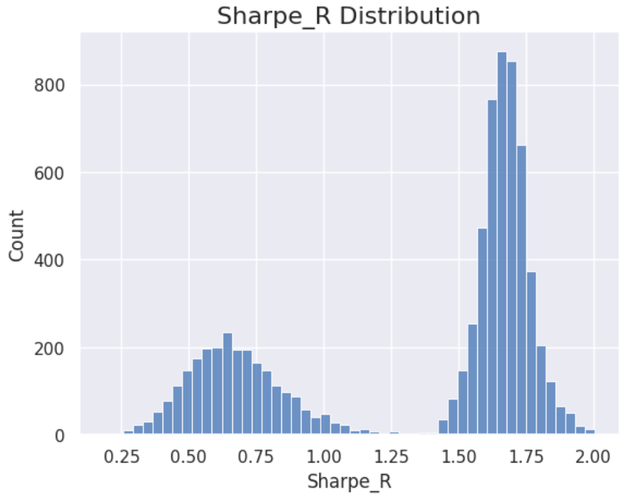
RESULTS AND DISCUSSION

7500 portfolio simulations

	Returns	Risk	Sharpe_R	ABC_Weight	BHN_Weight	FPT_Weight	GAS_Weight	HPG_Weight	HSG_Weight	HVN_Weight	MSB_Weight	NVL_Weight	PNJ_Weight	TCB_Weight	VCB_Weight	VHM_Weight	VIC_Weight	VJC_Weight	VPI
0	0.365814	0.225132	1.580468	0.093372	0.022754	0.059740	0.006515	0.093522	0.134163	0.030483	0.020265	0.062009	0.005522	0.131195	0.116357	0.012737	0.016654	0.060528	
1	0.103459	0.174695	0.534985	0.136938	0.086959	0.001910	0.011427	0.039617	0.024649	0.043452	0.026297	0.104335	0.093525	0.003574	0.046308	0.106890	0.119838	0.123101	
2	0.336064	0.201228	1.620371	0.133931	0.016020	0.067570	0.022558	0.066328	0.120373	0.032643	0.091134	0.122356	0.016649	0.135402	0.085435	0.059994	0.021122	0.001429	
3	0.396632	0.242769	1.592590	0.041186	0.040280	0.019888	0.133463	0.020414	0.229216	0.065418	0.014133	0.016613	0.030568	0.107021	0.006660	0.003994	0.019806	0.124365	
4	0.138856	0.176022	0.732047	0.142632	0.031897	0.059638	0.020878	0.021636	0.020080	0.031536	0.037418	0.090117	0.106343	0.073357	0.021203	0.071045	0.125137	0.133844	

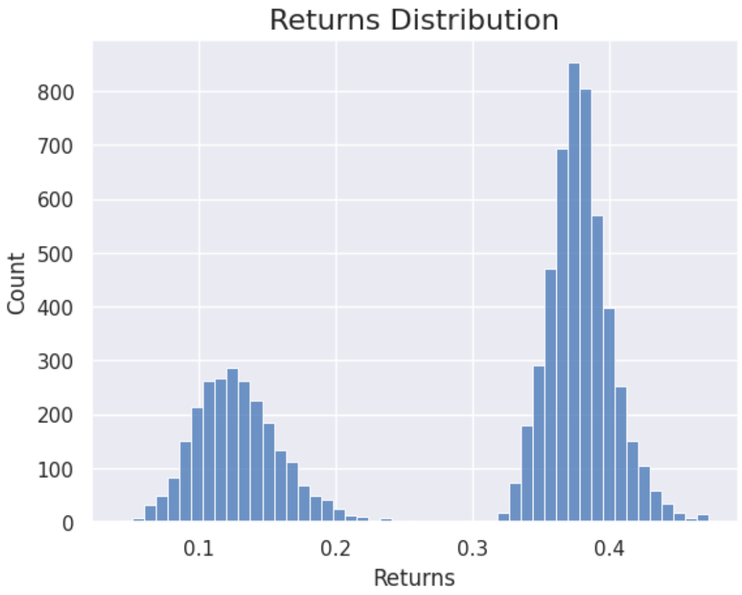


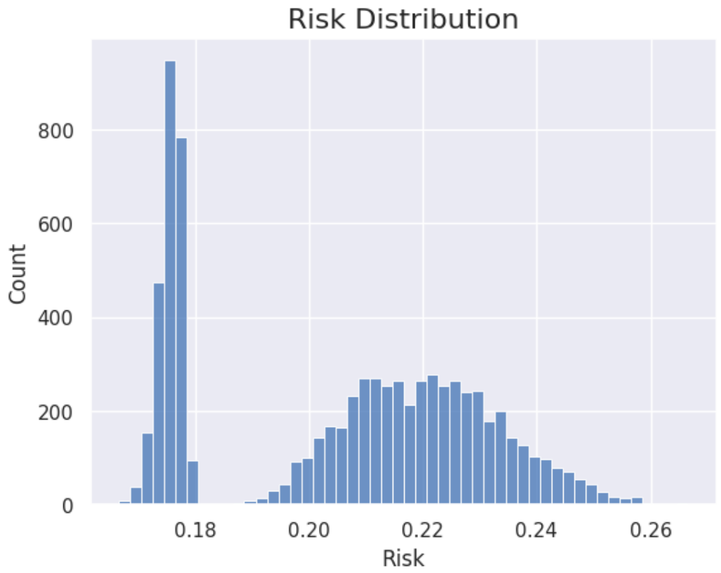


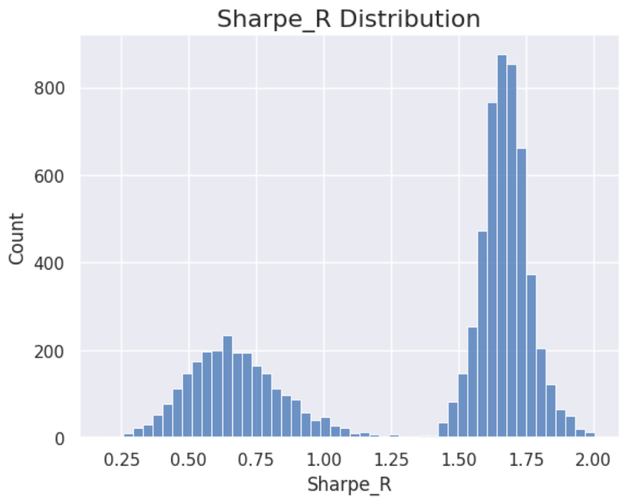


RESULTS AND DISCUSSION

The distributions show where portfolios containing these equity securities along with the used criteria can be found in terms of risk, return, and Sharpe ratio.

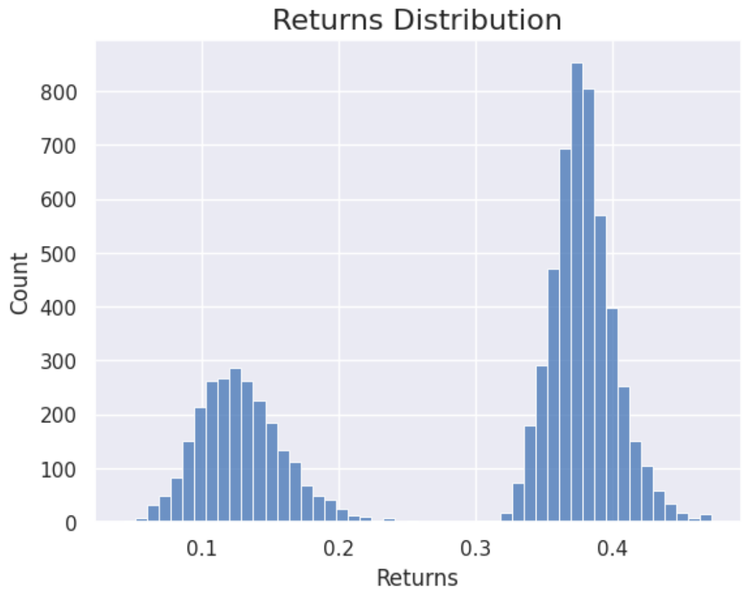


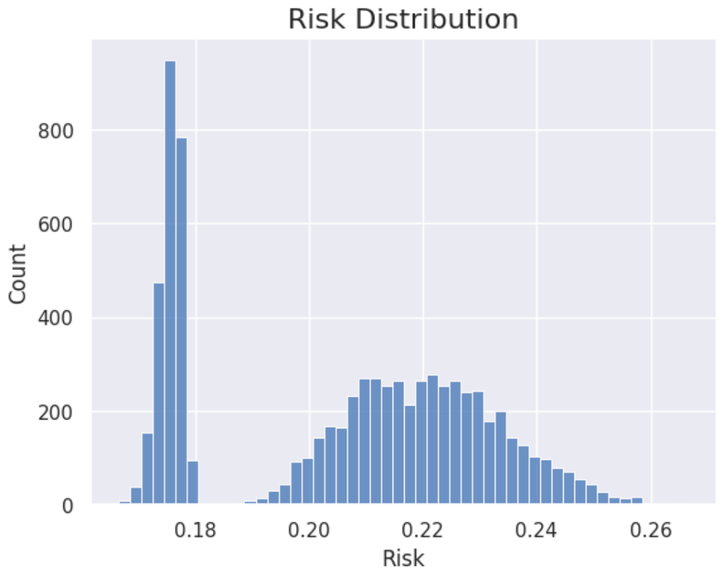


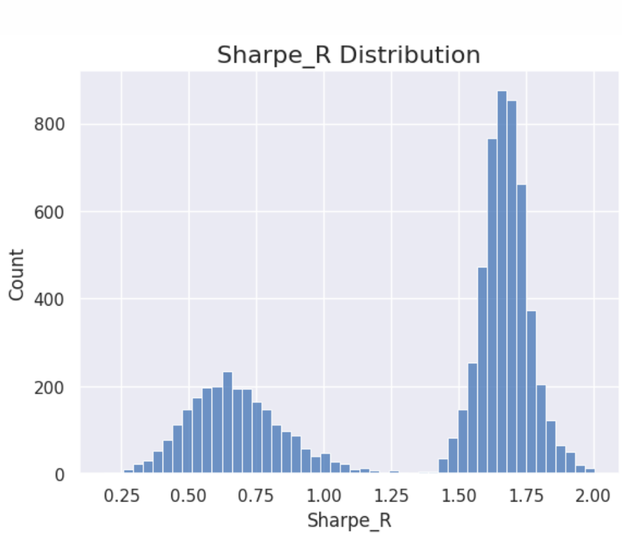


RESULTS AND DISCUSSION

For returns, it can be seen most are around more than 30% in annual returns, so any portfolio that can have something greater than that such as the ones at 45% are better than most.

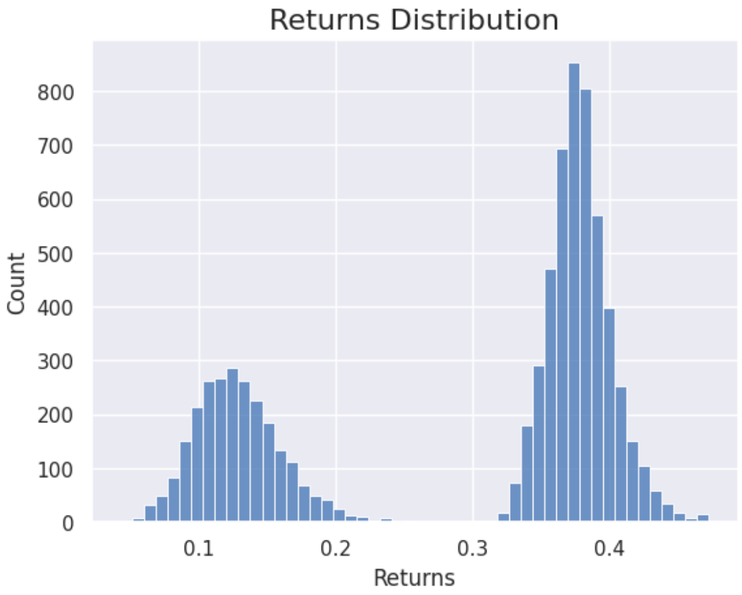


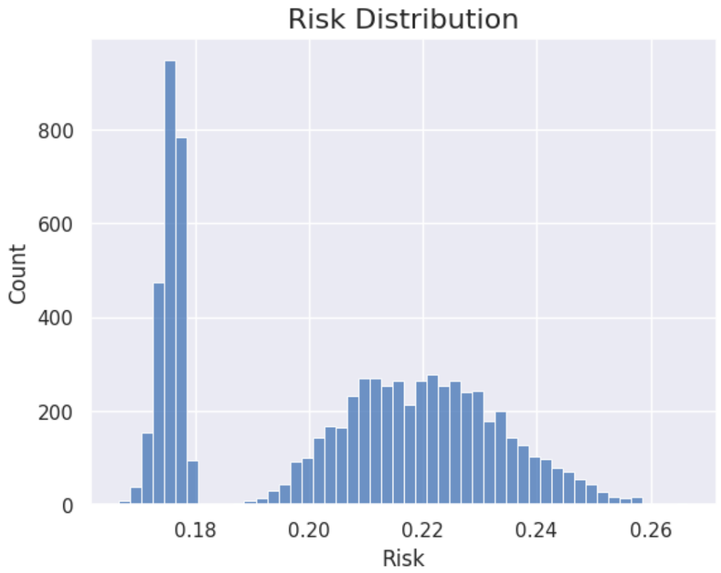


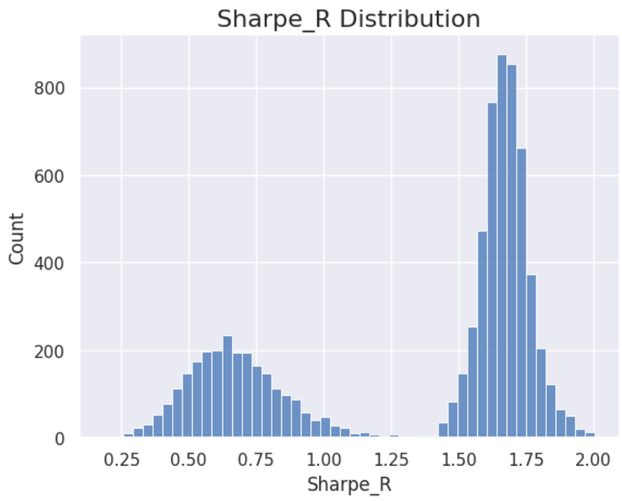


RESULTS AND DISCUSSION

Inversely, those with portfolios to the left under 30% can be understood to be underperforming with the given conditions and assets.

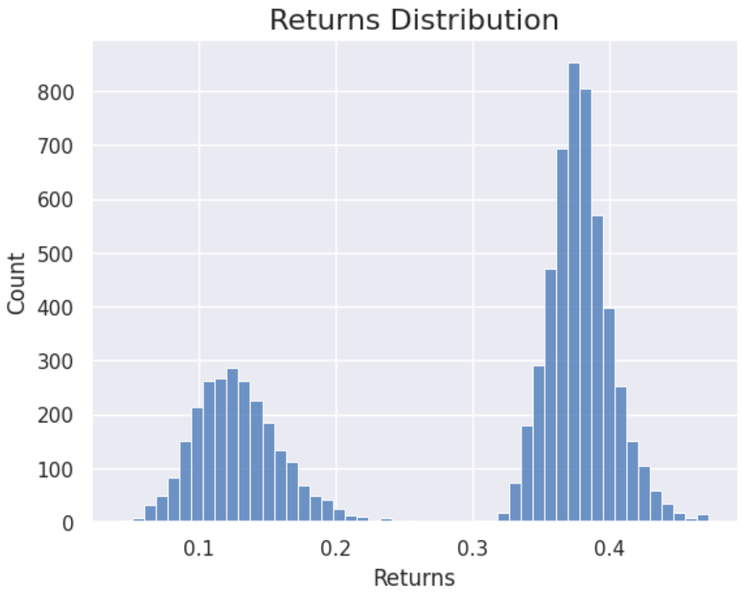


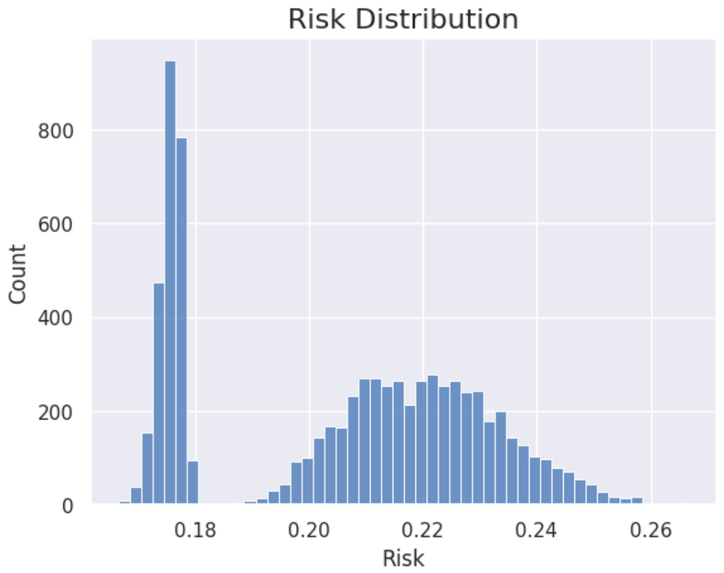


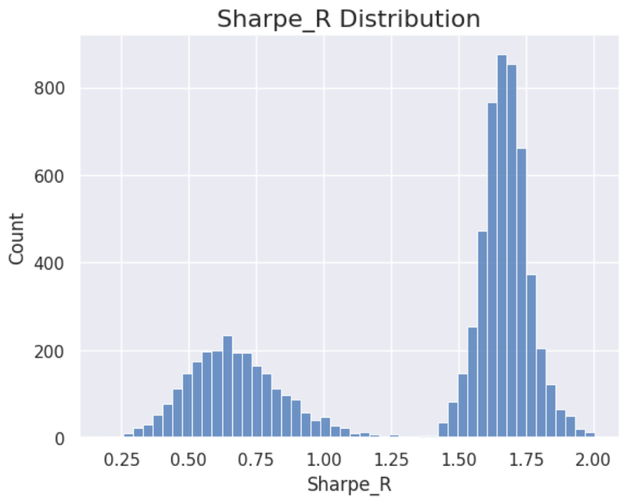


RESULTS AND DISCUSSION

The same idea can be understood from the risks generated. As seen, most had a volatility right left of 18% with quite a few being around 22%. The portfolios with risks above 23% and 26% can be seen as underperforming in regard to controlling risk under these conditions if that is an important aspect for the investor. Volatilities of 18% are the lowest and can be considered the highest if one is seeking smaller risk under these conditions.

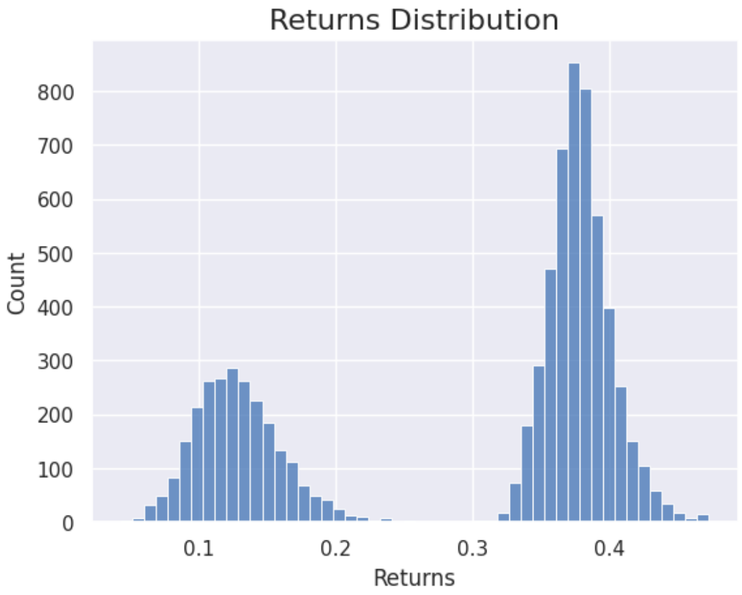


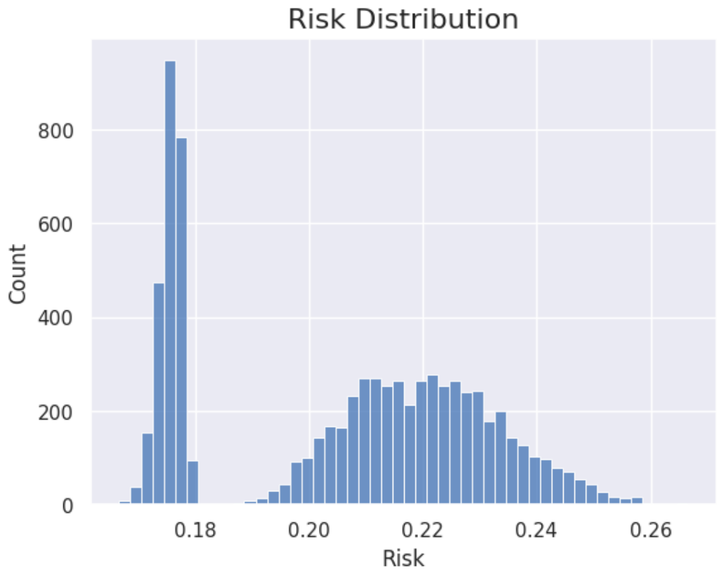


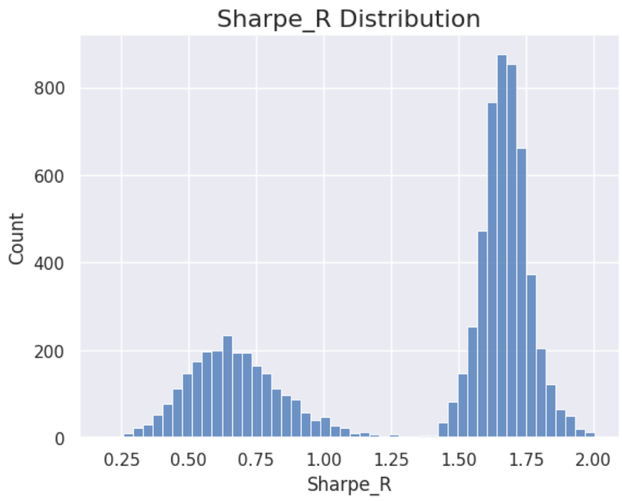


RESULTS AND DISCUSSION

Finally, the most extreme portfolios can be found from all the simulations and randomly generated portfolios. This gives the highest return one, the smallest risk one, and the highest Sharpe ratio one.







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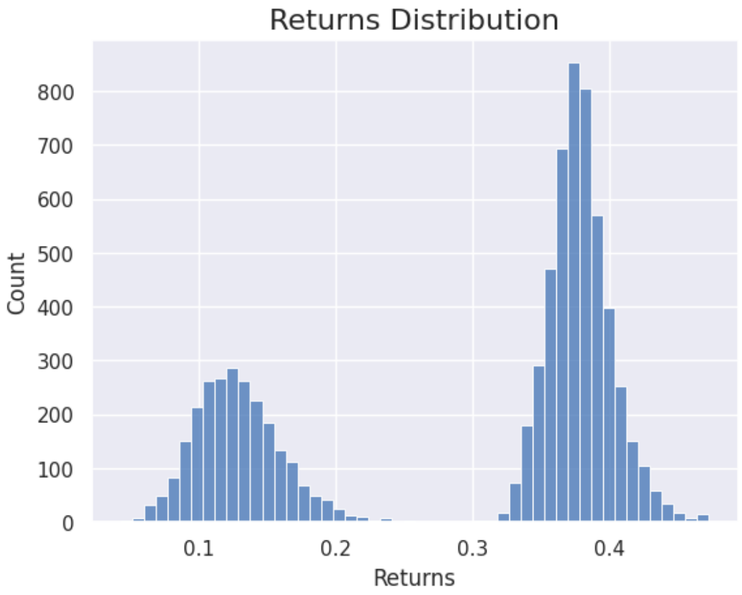
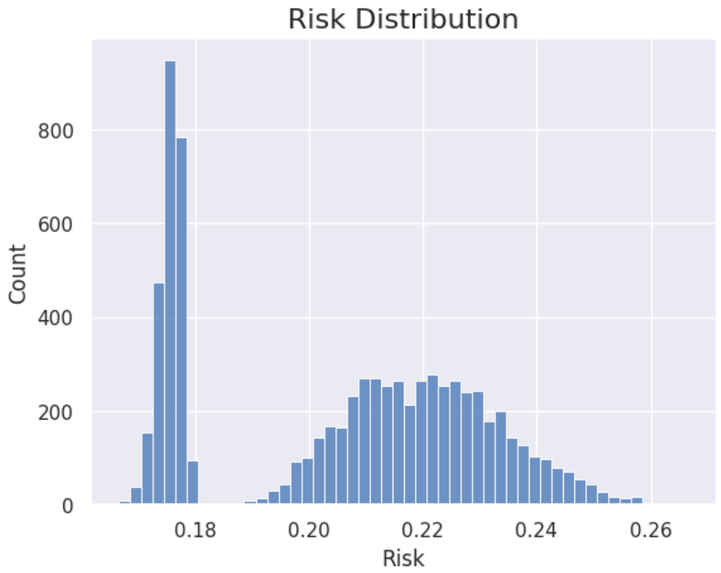
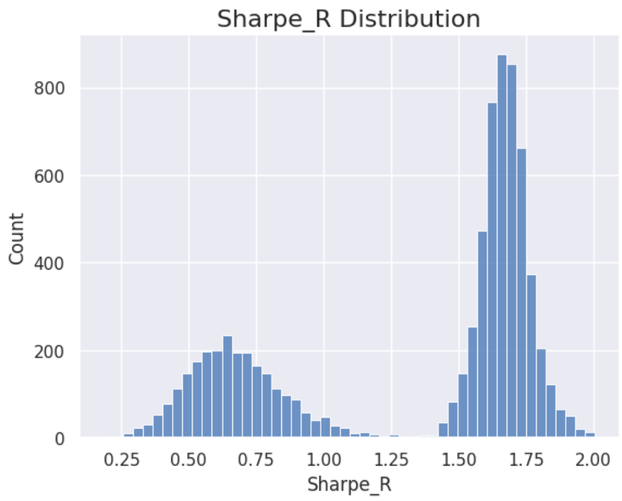
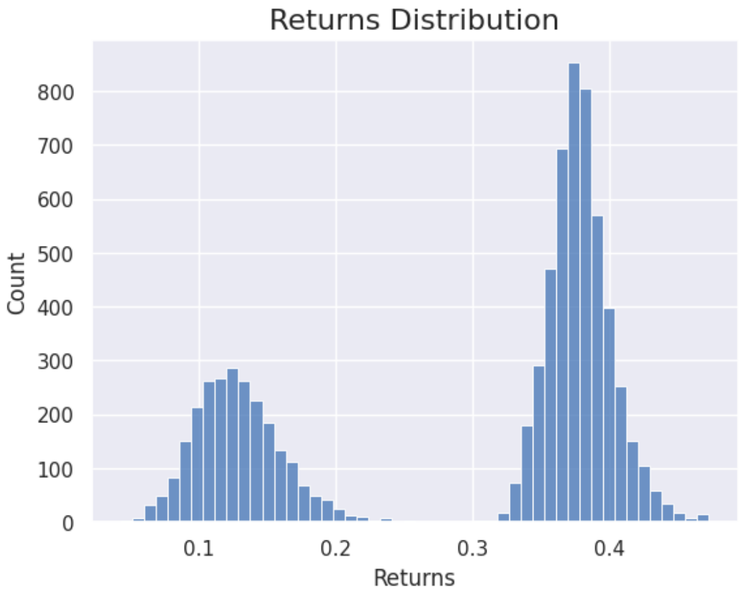


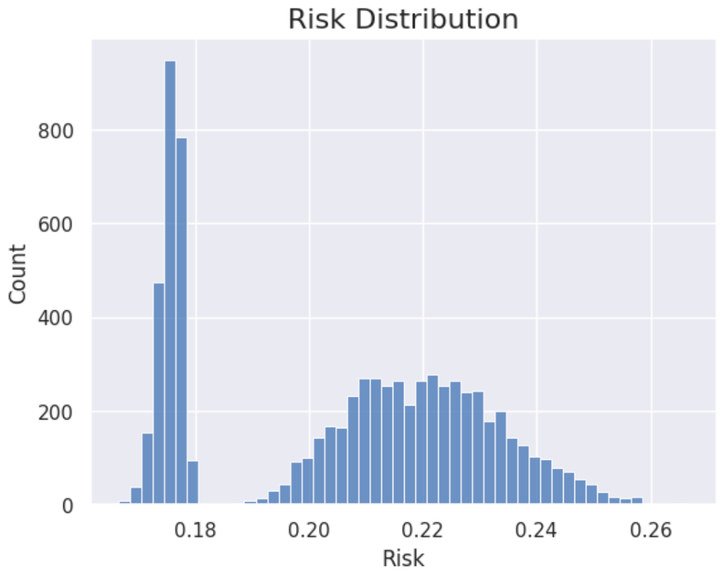


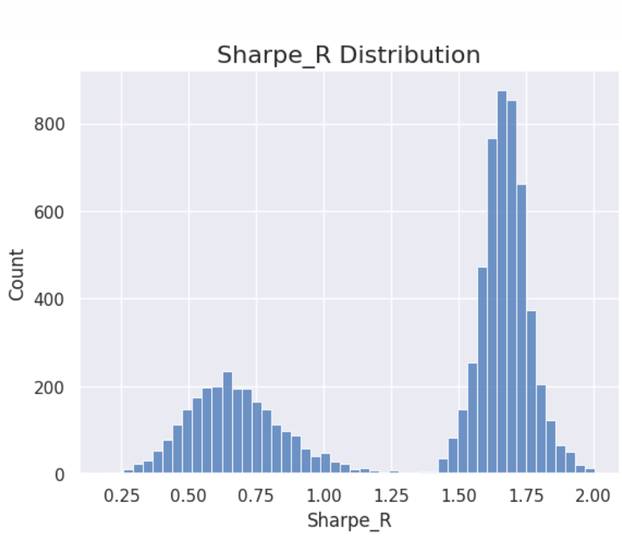


RESULTS AND DISCUSSION

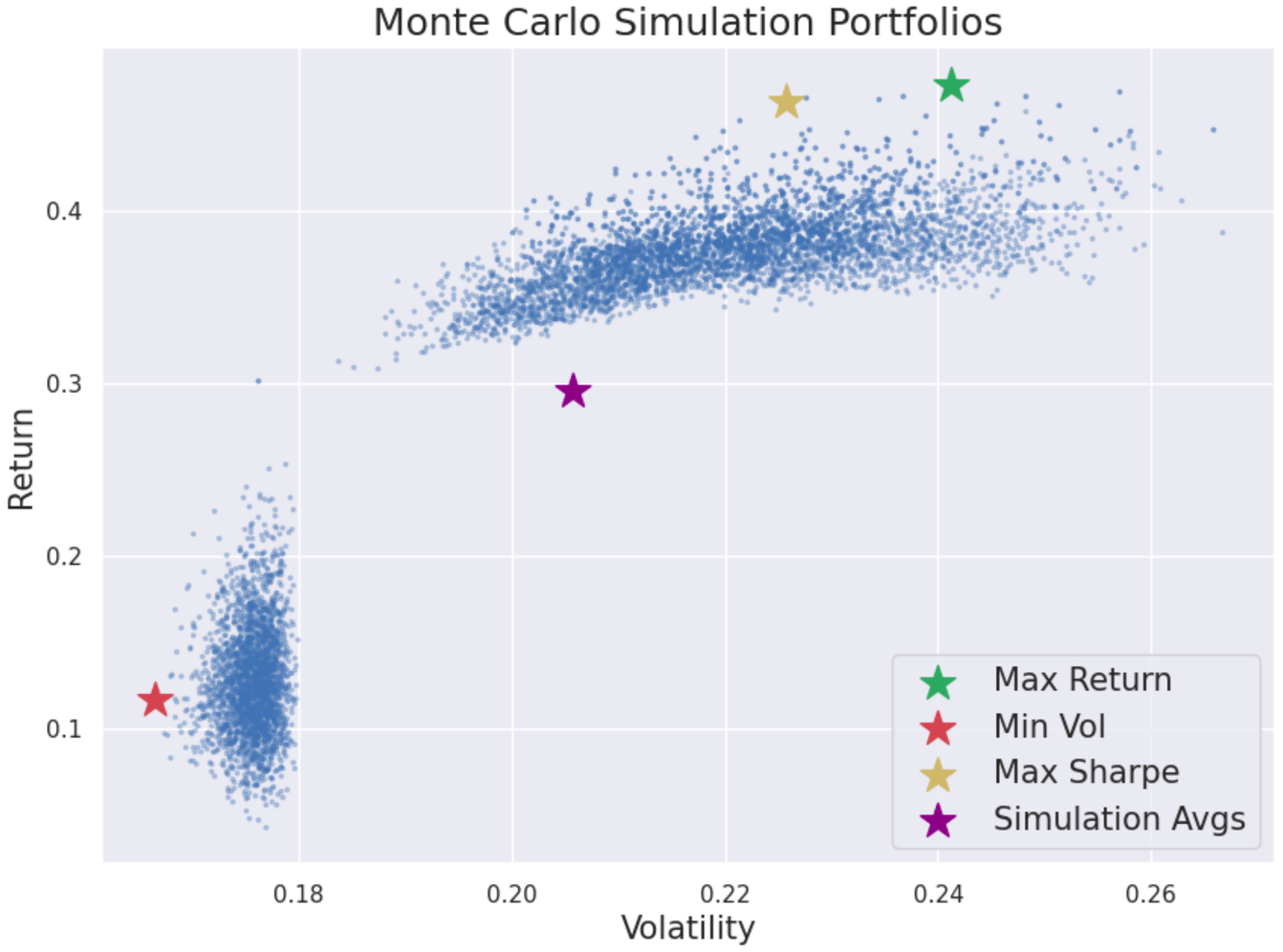
it is suggested to use the average portfolio based on return and risk using these metrics. Additionally, we can represent all portfolios on an efficient frontier scatter plot, which visually displays their positions and metrics relative to each other.





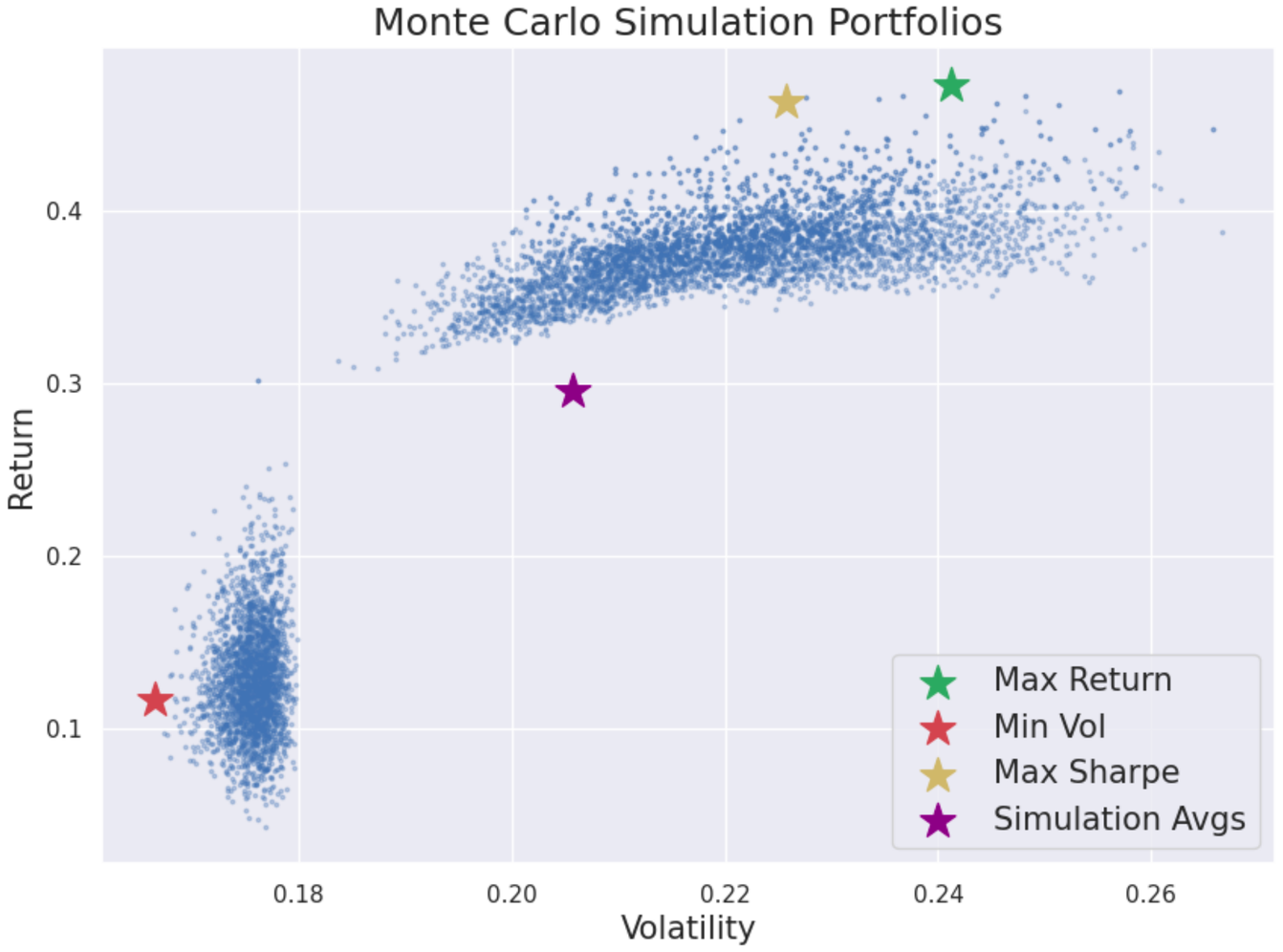


RESULT AND DISCUSSION



- Exhibits how Monte Carlo simulations can find an optimal portfolio, covers essentially all possible scenarios.
- How all of the portfolios compare to each other on the scatter plot built.
- Who wanted to maximize the returns could choose the green star portfolio while one that wanted to minimize risk above anything could choose the red star portfolio.

RESULT AND DISCUSSION



As an example, it is clear how the maximum Sharpe ratio portfolio (yellow star) is a better choice than the average metrics portfolio (purple star) since it has a much higher return while still having a smaller amount of risk.

By using basic filter in the output dataset, we can choose our desire portfolio with wanted properties based on the analysis.

CHALLENGES

- Computational complexity
- Data quality and availability
- Assumption and model selection
- Intepretation and decision making

FURTHER APPLICATION

- Other metrics can be used and applied with other methods
- Greater number of simulations and random generated portfolios can still be performed for greater accuracy and utility.
- This method can be applied to other methods such as Performance Evaluation and Scenario Analysis, Value at Risk (VaR) Estimation, portfolio diversification

CONCLUSION

- Monte Carlo simulation is a powerful tool for portfolio analysis and optimization, allow to balance between risk and return
- Application comes with challenges
- As technology advances, it remains an efficient tool

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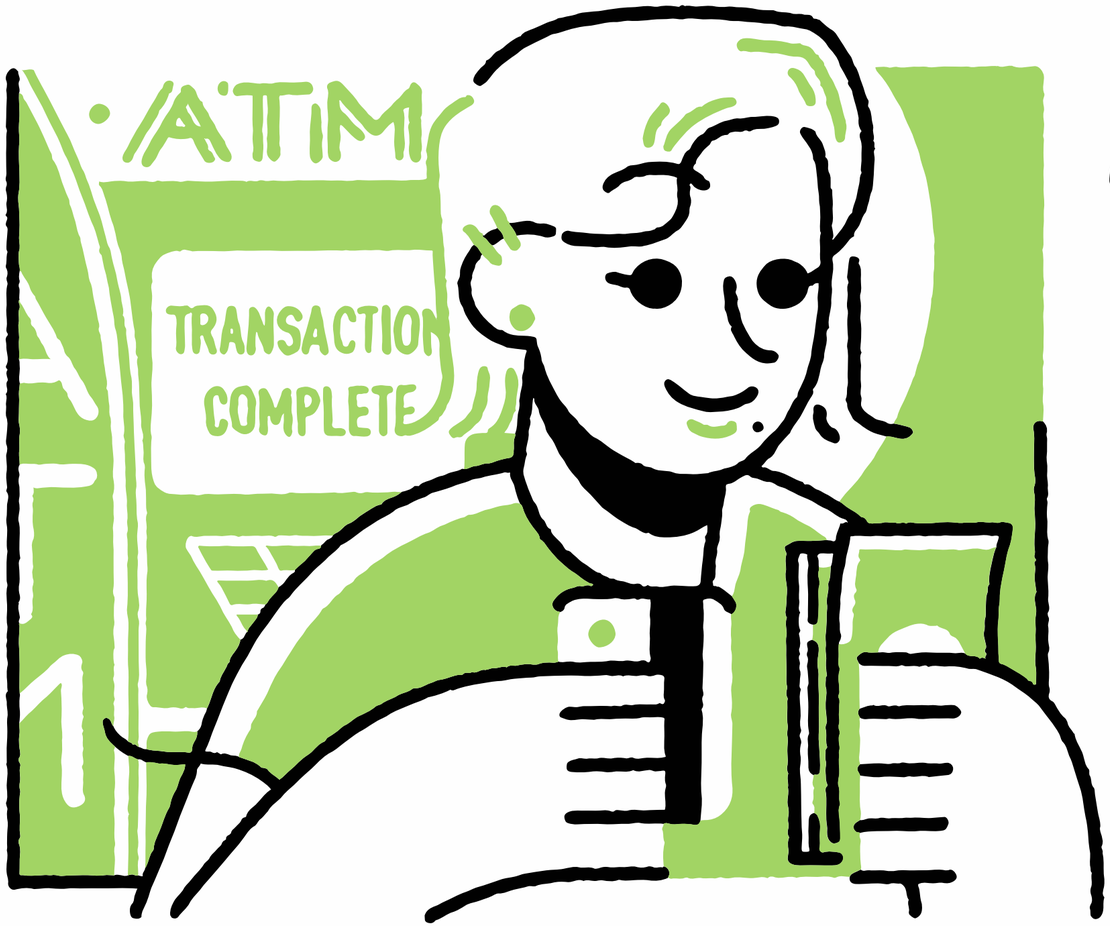

THANK YOU FOR LISTENING